Abstract

This dissertation focuses on the analysis of heart rhythm properties (based on EKG signals, specifically RR intervals) using monotonic series and entropic measures. The developed methodology aims to deepen the theoretical understanding of phenomena related to heart rate variability (HRV) and assess the applicability of these methods for diagnostic and classification purposes.

First, a literature review is presented, surveying key HRV analysis techniques, complexity-based methods, and heart rhythm asymmetry (HRA) indicators, especially in the context of sleep research. Subsequently, a continuous theoretical model based on the Weierstrass function with asymmetric noise is introduced. This model serves as a foundation for examining how asymmetry influences entropic parameters of monotonic series and for comparing these parameters with other approaches such as HRA and ADFA.

Next, these methods are applied to real EKG recordings, particularly with respect to sleep stage classification and atrial fibrillation detection. The dissertation investigates whether the entropy of monotonic series, combined with other measures of heart rate variability and complexity, allows effective differentiation between physiological and pathological states.

The final part of the work concerns the development of custom software tools that enable automated EKG signal analysis (e.g., for sleep stage detection or atrial fibrillation). This includes the processing of commercial PSG recordings to make them suitable for further scientific studies. In addition, the algorithms required for calculating sample entropy were improved to offer greater computational efficiency and clarity.

As a result, the dissertation provides novel theoretical insights into the role and structure of monotonic series in heart rhythm signals and practical tools that could be applied in both scientific research and clinical practice, particularly for diagnosing heart rhythm disorders and analyzing sleep.